

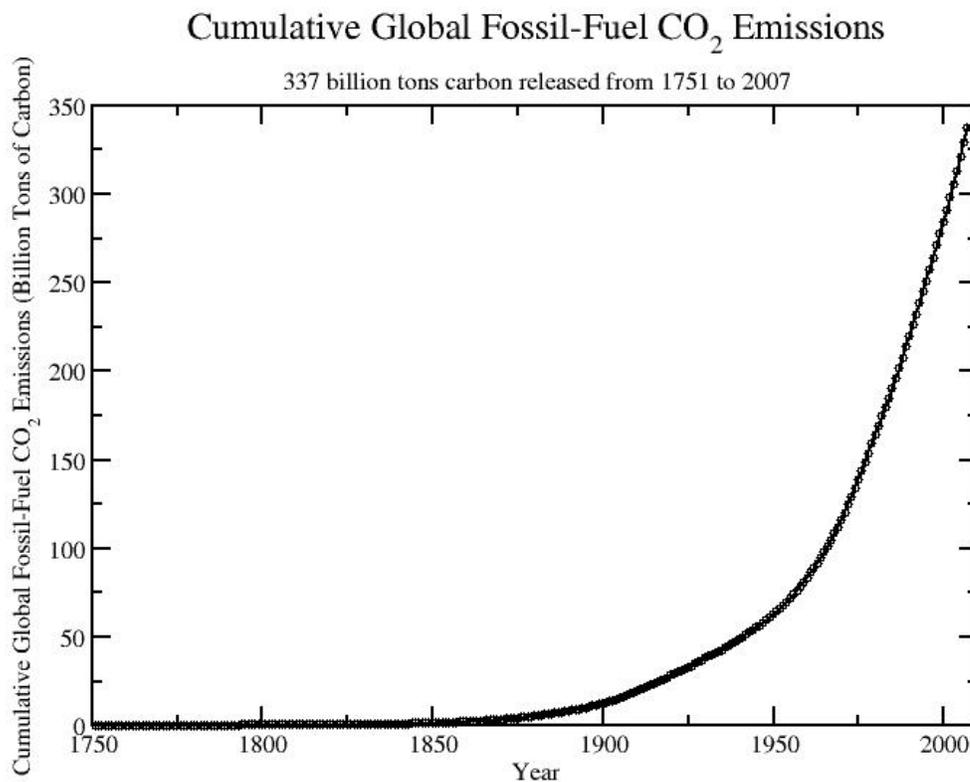
Introduction to Oceanography

EAS 4300

Homework #8:

Ocean carbon cycle

According to the US Department of Energy, the cumulative carbon emission due to the consumption of fossil fuels is approximately 337 GTC as of 2007 (See the Figure below).



- (1) Pre-industrial atmospheric pCO₂ is approximately 280 ppmv. If the emitted fossil fuel carbon entirely remains in the atmosphere, what would be the concentration of atmospheric CO₂ in 2007? Answer in units of ppmv.
- (2) Observed atmospheric pCO₂ is approximately 380 ppmv in 2007. Out of 337 GTC of historic fossil fuel emission, how many GTC have already been absorbed into the land and oceanic reservoirs?

- (3) In the last few years, fossil fuel carbon emission has been at a rate of about 8 GTC/year. However, atmospheric carbon dioxide has been only rising at a rate of about 2 ppmv/year. How many GTC of carbon is absorbed into the ocean and land surfaces each year?
- (4) Assuming that the ocean and land will continue to absorb carbon dioxide at the same rate as today, how much reduction in carbon emission is necessary in order to stop further increase in the atmospheric pCO₂?

Remember that the equilibrium carbonate chemistry can be approximated by the buffer factor relation as follows:

$$\frac{\delta pCO_2}{pCO_2} = B \frac{\delta DIC}{DIC}$$

The magnitude of B varies from about 8 in the tropics to about 16 in the high latitudes. Let's assume B=10 for our theoretical calculation. Also assume that the pre-industrial ocean contains approximately 38,000 GTC.

- (5) After several centuries, the thermohaline circulation will equilibrate the deep ocean carbon reservoir with the changes in the atmospheric CO₂. If we stabilize the atmospheric CO₂ at 450 ppmv, how many GTC of carbon will eventually be absorbed into the ocean?
- (6) Alternately, if we decide to stabilize at 350 ppmv, how many GTC of carbon will eventually be absorbed into the ocean?